

I CLAIM:

1. A method for forming a solder joint in an electronic assembly having one or more copper connection sites, the method comprising the steps of:
  - applying a thin nickel layer to at least one copper connection site;
  - applying a diffusion layer to the thin nickel layer;
  - positioning lead-free solder adjacent to the diffusion layer;
  - reflowing the solder thereby forming a solder joint at the copper connection site.
2. A method according to claim 1 wherein the thin nickel layer is applied to a thickness of greater than about 0.05 microns.
3. A method according to claim 1 wherein the thin nickel layer is applied to a thickness of less than about 0.05 microns.
4. A method according to claim 1 wherein the thin nickel layer is applied to a thickness of less than about 0.28 microns.
5. A method according to claim 1 wherein the thin nickel layer is applied to a thickness within the range of approximately 0.05 microns to approximately 0.28 microns.
6. A method according to claim 1 wherein the diffusion layer is applied to a thickness of greater than about 0.1 microns.
7. A method according to claim 1 wherein the diffusion layer is applied to a thickness of less than about 0.3 microns.

8. A method according to claim 1 wherein the diffusion layer is applied to a thickness within the range of approximately 0.1 microns to approximately 0.3 microns.
9. A method according to claim 1 wherein the diffusion layer comprises palladium.
10. A method according to claim 1 wherein the diffusion layer comprises gold.
11. A method according to claim 1 wherein the step of reflowing the solder further comprises the formation of a copper-tin intermetallic compound bond between the copper connection site and the solder.
12. A method according to claim 1 wherein the step of reflowing the solder further comprises the formation of a copper-nickel-tin intermetallic compound bond between the copper connection site and the solder.
13. A solder joint for a semiconductor apparatus assembly, wherein the assembly has at least one copper connection site, the solder joint comprising:
  - a thin nickel layer on at least one copper connection site;
  - a diffusion layer on the thin nickel layer; and
  - lead-free solder joined to the copper connection site.
14. A solder joint according to claim 13 wherein the solder joint further comprises a copper-tin intermetallic compound.
15. A solder joint according to claim 13 wherein the solder joint further comprises a copper-tin-nickel intermetallic compound.

16. A solder joint according to claim 13 wherein the thin nickel layer comprises nickel having a thickness of greater than about 0.05 microns.
17. A solder joint according to claim 13 wherein the thin nickel layer comprises nickel having a thickness of less than about 0.28 microns.
18. A solder joint according to claim 13 wherein the thin nickel layer comprises nickel having a thickness within a range of between approximately 0.05 microns and approximately 0.28 microns.
19. A solder joint according to claim 13 wherein the diffusion has a thickness of greater than about 0.1 microns.
20. A solder joint according to claim 13 wherein the diffusion layer has a thickness of less than about 0.3 microns.
21. A solder joint according to claim 13 wherein the diffusion layer has a thickness within a range of between approximately 0.1 microns and approximately 0.3 microns.
22. A solder joint according to claim 13 wherein the diffusion layer comprises palladium.
23. A method according to claim 13 wherein the diffusion layer comprises gold.

24. A solder joint for a semiconductor apparatus assembly, wherein the assembly has at least one copper connection site, the solder joint comprising:
- a thin intermetallic compound layer comprising copper-tin bonded to the copper connection site;
  - a thin nickel layer bonded to the thin intermetallic compound layer;
  - lead-free solder encapsulating the thin nickel layer and the intermetallic compound layer forming a solder joint.
25. A solder joint according to claim 24 wherein the thin intermetallic compound layer further comprises copper-nickel-tin.
26. A solder joint according to claim 24 wherein the lead-free solder encapsulating the thin nickel layer further comprises diffused gold.
27. A solder joint according to claim 24 wherein the lead-free solder encapsulating the thin nickel layer further comprises diffused palladium.
28. A solder joint according to claim 24 wherein the thin nickel layer comprises nickel having a thickness sufficient to retard the formation of copper-tin intermetallic compound over time.
29. A solder joint according to claim 24 wherein the thin nickel layer comprises nickel having a thickness of less than about 0.28 microns.
30. A solder joint according to claim 24 wherein the thin nickel layer comprises nickel having a thickness of greater than about 0.05 microns.

31. A solder joint according to claim 24 wherein the thin nickel layer comprises nickel having a thickness within a range of between approximately 0.05 microns and approximately 0.28 microns.

32. A solder joint according to claim 24 wherein the intermetallic compound layer further comprises undulations.

33. A solder joint for a semiconductor apparatus assembly, wherein the assembly has at least one copper connection site, the solder joint comprising:

- a thin undulating intermetallic compound layer comprising copper-nickel-tin bonded to the copper connection site;

- a thin nickel layer bonded to the thin intermetallic compound layer; and

- solder encapsulating the thin nickel layer and the thin undulating intermetallic compound layer forming a solder joint, the solder joint further comprising a relatively small quantity of diffused palladium.